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Abstract

STUDIES OF THE FISSION PROCESS INDUCED BY THERMAL NEUTRONS

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1. With a high-intensity neutron beam available from the NRU reactor, the prompt mass and kinetic-energy distributions resulting from the thermal-neutron fission of ^{233}U, ^{235}U and ^{239}Pu have been re-examined using the time-of-flight technique to measure simultaneously the velocities of the fragment pairs. With the high resolution now available a fine structure in the mass yields is observed. This structure becomes more pronounced at high total kinetic energies where the excitation energy is low. There is a strong correlation between the positions of the maxima in the mass yields and maxima in the energy release for even-even fragments. A similar fine structure in the spontaneous fission of ^{252}Cf has been shown to be associated with the same heavy even-even fragments.

2. The large decrease (35 MeV) in the total kinetic energy for nearly symmetric mass divisions has been shown to be connected with an increase in the total yield of prompt neutrons. This has been done for a ^{233}U target in an experiment to measure the correlation in energy and angle of the prompt neutrons with fission-fragment mass and energy. Neutron flight paths of 1 meter were set up at angles of 10°, 25°, 45° and 80° to the fragment flight paths. Because the background is relatively high at the larger angles, only the data taken at 10° has yet been analyzed in detail.

3. The average number, ν, of neutrons emitted by a fragment varies with fragment mass and is in excellent agreement with the indirect determination made by Terrell from a comparison of prompt and final mass yields. ν is nearly zero at mass 80, rises to a peak near mass 110, falls to zero near mass 130, then rises monotonically through the heavy-fragment group.

4. In contrast to the sawtooth behaviour of ν, the variation of average neutron kinetic energy is symmetrical about the mass symmetry point. If the neutron energy is taken as an indicator of

the temperature of the fragment, it follows that the temperature of a mass 132 fragment in the neighbourhood of the neutron binding energy is equal to that of a mass 102 fragment some 25 MeV higher.

5. These observations suggest that there is a great dissimilarity in the stiffness of the two fragments and that they are highly deformed with low temperatures at the point of scission, the deformation energy being converted to excitation energy at a later stage. The observed variation of ν with the total internal energy of the fragments supports this view.